# Forest Inventory, Analysis

# and

# Management Plan

# for

# Joint Systems Manufacturing Center-Lima

# 2006

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# Table of Contents

Page

INTRODUCTION ..... 1

LOCATION, GENERAL DESCRIPTION AND BACKGROUND ..... 1

Figure 1 – General location map of JSMG-LIMA ..... 2

METHODS ..... 3

Plot Data Collection ..... 3

Figure 2 – Forested areas and delineated wetlands ..... 4

RESULTS ..... 7

Figure 3 – Forest stand map ..... 9
Figure 4 – EAB hazard rating map ..... 10
Figure 5 – Gypsy moth hazard rating map ..... 11
Figure 6 – Forest cover type map ..... 12
Table 1 – Tree species located in the 10-BAF prism plots ..... 13
Table 2 – Tree, shrub, woody stem and vine species located in the regeneration plots ..... 14

DISCUSSION AND RECOMMENDATIONS ..... 15

Figure 7 – Location of EAB infestation near JSMC-LIMA ..... 16
Figure 8 – Counties where EAB infestations have been detected ..... 17

WORK SCHEDULE ..... 20

LITERATURE CITED ..... 20

APPENDIX A ..... 21

## INTRODUCTION

The purpose of this forest management plan is to promote healthy, productive and vigorous forests at the Joint Systems Manufacturing Center-Lima (JSMC-LIMA). Although this facility is primarily an industrial complex, it is still responsible as a steward of public lands for developing and maintaining a progressive program of natural resource management.

This natural resource management program should include a forest management program based on ecologically sound practices. These practices can improve the overall health of the forests, stimulate growth, create a forest that is more resistant and resilient to insect and disease pests, and may produce some revenue.

A work schedule for the next decade is included in this forest management plan. This plan should be updated at least every ten years.

## LOCATION, GENERAL DESCRIPTION AND BACKGROUND

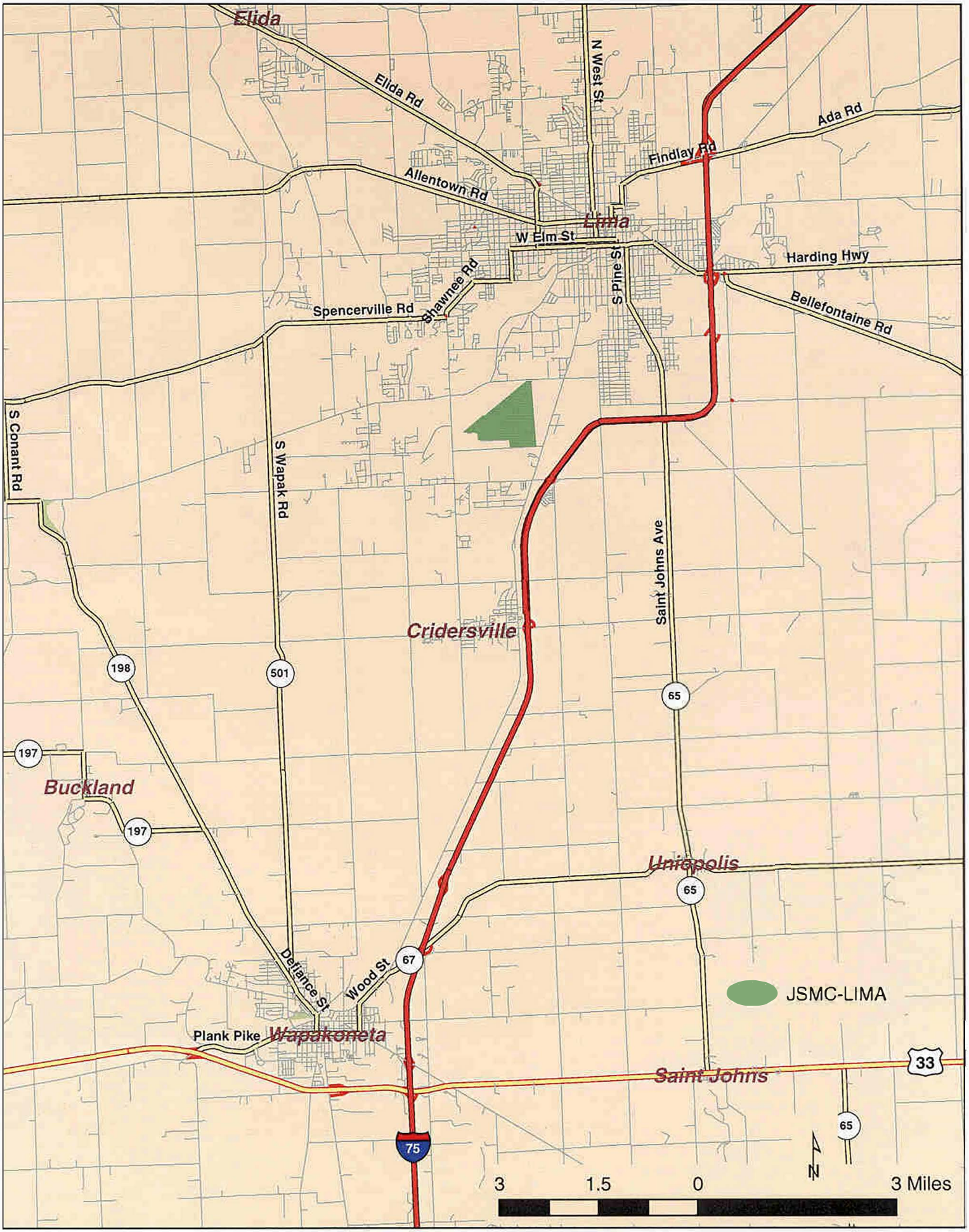
The Joint Systems Manufacturing Center-Lima (JSMC-LIMA) is a 369 acre Department of Defense facility located approximately 1 mile south of Lima, Ohio (Figure 1). General Dynamics Land Systems operates this government-owned, contractor-operated manufacturing facility. Current JSMC-LIMA production programs include the Stryker FoV upper hull assembly, Abrams Main Battle Tanks, Advanced Amphibians Assault Vehicles, and various prototypes.

The terrain is practically flat at JSMC-LIMA with elevation varying less than 20 feet. The average elevation is 864 feet above sea level. Blount silt loam, Pewamo silty clay loam and Morley silt loam are the common soil types. The Blount and Pewamo soil types are poorly drained, while the Morley soil type is moderately well drained. JSMC-LIMA is comprised by approximately 42 buildings (covering approximately 37 acres), several primary and secondary roads, parking lots, pipelines, wetlands, abandoned fields, grassy areas, forested areas, a picnic shelter, a ball field, three ponds, a 1.42 mile oval test track with a 0.61 mile diagonal test track, test slopes and a deep-water fording pit.

Construction of this facility started in May of 1941 and was completed in November of 1943. Over the years this facility has been run by several contractors (United Motor Services, Ford Motor Corporation and Chrysler Defense Incorporated), has had several names (Lima Ordinance Depot, Lima Ordinance Modification Center, US Army Detroit Arsenal Tank Plant/US Army Modification Center-Lima Complex, Lima Army Tank Center and Lima Army Tank Plant), has had several functions (manufacturing of gun barrels, vehicle storage, vehicle modification and production of new combat vehicles) and has changed in size six times (ranging from 169 to 465 acres).

The objective of forest management at JSMC-LIMA is to maximize the efficient use of trees and forests consistent with the mission of the facility. The facility wants the forested areas to provide a sound barrier to buffer the surrounding neighborhoods from tank noise during testing activities, provide a visual barrier of the site, create wind breaks, and serve as habitat for wildlife. Past forest management activities have included seedling planting operations which occurred mainly in the 1960's and a timber harvest. Some of these seedlings were destroyed when the test track was constructed while others seedlings were planted on land that is now Heritage Park.

Figure 1. General location map of JSMC-LIMA



Approximately 309 trees, containing 87,000 board feet, were harvested at JSMC-LIMA in 1985. Most of the trees harvested during this forest management activity were either mature or over-mature.

No plant or animal species listed as threatened or endangered by the U.S. Fish and Wildlife Service or the Ohio Department of Natural Resources is know to occur on or adjacent to JSMC-LIMA. Habitat for two species, the blue spotted salamander and the Indiana Bat, exists at this facility. The nearest confirmed colony of the Indiana Bat is located approximately 80 miles from this facility.

Two forest pests that could potentially have an impact on the forest resources at JSMC-LIMA are the emerald ash borer (EAB), *Agrilus plannipennis* and the gypsy moth, *Lymantria dispar* (L.).

## METHODS

Forested areas were delineated from natural resource maps of JSMC-LIMA and through interpretation of satellite photography. The boundaries of these forested areas were refined during the cruise. Most forested areas at JSMC-LIMA are small and discrete. A contiguous group of trees larger than .25 of an acre was classified as a stand. By definition, a stand is a contiguous group of trees sufficiently uniform in species composition, arrangement of size classes and condition to be a homogeneous and distinguishable unit. Minor variations in species composition and or size classes may occur in a stand due to differences in drainage, elevation, slope, aspect, etc. The forested areas and delineated wetlands (Lichvar and Sprecher, 1997), along with some of the other features of JSMC-LIMA are shown in Figure 2.

During the cruise, a 10 basal area factor (BAF) prism plot along 1/1000 acre regeneration plot were established at every sample point in each stand. The distance between and the number of sample points depended on the uniformity of trees and the size and shape of each individual stand.

Information collected in each prism plot included species, diameter breast height (dbh), crown class and crown condition for trees with a dbh of 2" or greater. In the regeneration plots, trees, shrubs and woody stems less than 2"dbh along with vines and herbaceous material were tallied and recorded by species..

### Plot Data Collection

A total of 75 prism plots and 75 regeneration plots were established in the 12 stands delineated during the cruise. Stand number, acres, average dbh, basal area, trees per acre, cover type, EAB hazard rating, gypsy moth hazard rating, species composition, size class distribution, regeneration and field notes are given for each stand. The following is brief description of each stand entry .

Stand Number – Stands were numbered in the order in which they were cruised.

Figure 2. Forested areas and wetlands at JSMC-LIMA

Acres – Number of acres in the stand, rounded to the nearest tenth of an acre.

Average DBH – Average dbh is the summation of the dbh from all the "in" trees of a stand divided by the total number of "in" trees.

Basal Area – Basal area is a term used to describe stand density. It's defined as the total cross-sectional area of the trees in a stand measured at dbh and is expressed in square feet per acre. Basal area in a stand usually increases with stand maturity. Following are two examples of the relationship between dbh and basal area. If all the trees in a stand double in size over a period of time, the basal of the stand will increase four fold. Comparing basal area of individual trees at a given time, it would take four 10" dbh trees to have the same amount of basal area of one 20" dbh tree.

Number of Trees per Acre – The number of trees per acre is another way to describe stand density. In simple terms, it is the number of trees in a stand expressed on a per acre basis. Unlike basal area which typically increases with stand maturity, the number of trees usually decreases with stand maturity. Although a stand may start out with 30,000-50,000 stems per acre, there may only be 100-300 trees per acre when the stand is mature. In this plan, the number of trees per acre refers only to trees with the dbh of 2" or greater.

Cover Type – Cover type is a descriptive classification of a stand based on present occupancy by specific tree species. The following classifications were used to describe the surveyed forested areas. The forest cover types described by the Society of American Foresters were used as a guide, but modified slightly to accommodate the forest types found at JSMC-LIMA.

> Elm-Ash-Cottonwood – Elm species, ash species and eastern cottonwood, along with two associated species, northern hackberry and red maple account for 50 percent or more of the basal area in a stand. Elm, ash and eastern cottonwood alone account for at least 40 percent of the basal area.
>
> Oak-Hickory – Oak species and hickory species account for 50 percent or more of the basal area in a stand.

**EAB Hazard Rating** – EAB hazard rating is a descriptive classification of a stand based on its likelihood of being attacked and damaged when EAB invades JSMC-LIMA. EAB attacks ash trees and usually the infested trees die within 4 to 5 years. Although EAB adults do feed on ash foliage, little damage is caused by this activity. The larvae stage is when EAB causes the most damage. EAB larvae feed in the cambium between the bark and wood which produces galleries that can girdle and kill branches and eventually the entire tree. The EAB hazard rating classifications used for this plan along with their accompanying criteria are listed below.

| | |
|---|---|
| Low: | Ash species account for 10 percent or less of the basal area in a stand. |
| Moderate: | Ash species account for 11-20 percent of the basal area in a stand. |
| High: | Ash species account for 21-30 percent of the basal area in a stand. |
| Very High: | Ash species account for 31 percent or more of the basal area in a stand. |

**Gypsy Moth Hazard Rating** – Gypsy moth hazard rating is a descriptive classification of a stand based on its likelihood of being attacked and damaged during a gypsy moth outbreak. Stands that contain a large percentage of tree species that are readily fed upon by gypsy moth larvae during all larvae stages will have a higher hazard rating than a stand that is comprised

mostly of tree species that are not acceptable hosts. Susceptible tree species (Mosher 1915) that are found at JSMC-LIMA include common apple, box elder, hawthorn, hop-hornbeam, American basswood, big tooth aspen, black willow and oak species. The gypsy moth hazard rating classifications used during this inventory and analysis along with their accompany criteria are listed below and adopted from Herrick and Gansner (1986) and Gottschalk (1993).

| | |
|---|---|
| Low: | Susceptible tree species account for 20 percent or less of the basal area in a stand. |
| Moderate: | Susceptible tree species account for 21-50 percent of the basal area in a stand. |
| High: | Susceptible tree species account for 51-80 percent of the basal area in a stand. |
| Very High: | Susceptible tree species account for 81 percent or more of the basal area in a stand. |

**Species Composition**- Species composition is listed in descending order of occurrence. The first number after each species is the percent of the stand's trees that are comprised by that species while the number in parenthesis is the percent of the stand's basal area that is accounted for by that species. These two numbers may be fairly similar or they may differ greatly. An example species composition is offered below.

Species composition: AE 60% (20%), SH 25% (25%), NRO 15% (55%)

In this sample stand, American elm (AE) accounts for 60 percent of the trees yet only 20 percent of the basal area, shagbark hickory (SH) accounts for both 25 percent of the trees and basal area, while northern red oak (NRO) accounts for 15 percent of the trees and 55 percent of the basal area. A quick rule of thumb is that when the number of trees is higher than the basal area for a particular species, the trees of this species are for the most part smaller than an average tree in the stand. Conversely, when the basal area is higher than the number of trees for a particular species, the trees of that species are larger than an average tree in the stand. In this example, there would be a lot of smaller American elms, a moderate amount of average size shagbark hickory and a few larger northern red oak.

**Size Class Distribution** – Size class distribution tells quite a lot about a stand's structure. Even though two stands may have very similar average dbh, the size class distribution may vary significantly. For example one stand may have 300 trees per acre comprised by a hundred 8" dbh trees, a hundred 9" dbh trees and a hundred 10" dbh trees. Another stand also has 300 trees per acre but is comprised by a hundred 4" dbh trees, a hundred 9" dbh trees and a hundred 14" dbh trees. Both of these stands have the same average dbh of 9" but the size class distribution and the stand structure vary significantly. The three size classes used for this plan are listed below.

| | |
|---|---|
| < 12" DBH | (comprised by saplings and pole timber size trees) |
| 12-20" DBH | (comprised by small and medium size saw timber size trees) |
| > 20" DBH | (comprised by large saw timber size trees) |

The first number after each size class is the percent of the stands' trees in that size class while the number in parenthesis is the percent of the stand's basal area in that size class. Looking at the size class distribution of Stand 1 (located in the Appendix), 96 percent of the trees are less than 12" dbh, 3 percent of the trees range from 12"- 20" dbh while 1 percent of the trees are greater than 20" dbh. Looking again at Stand 1, 75 percent of the basal area is located in the less then 12" dbh class, 15 percent in the 12-20" dbh class and 10 percent in the greater than 20" dbh class.

**Regeneration** – Regeneration data is based only on stems less than 2" dbh and includes commercial tree species, non-commercial tree species, shrubs, woody stems, vines, and miscellaneous herbaceous material. Due to their growth pattern, stems were not counted for species like poison ivy, grape vine, Virginia creeper and herbaceous material. Instead, percent ground cover estimates (in 5% classes) were made for these species.

**Field Notes** – Field notes are general observations made about each stand during the cruise. These subjective observations were made on such things as stand maturity, stand density, wetlands, past harvesting activities, past planting activities, regeneration, etc. Also the amount of stand mortality, both trees per acre and basal area, is included in the field notes.

## RESULTS

Individual stand results are presented in Appendix A. A summation of the combined stand results follows.

**Stand Number and Acres** – Twelve stands covering 85.3 acres were delineated and cruised. Stand acreage ranges from 0.9 to 40.7 acres and averages 7.1 acres. Only two of the stands were greater than 10 acres while eight of the stands were smaller than five acres. The forest stand map is presented in Figure 3.

**Average DBH** – The average dbh for all stands ranges from 6.4 to 13.2 inches and averages 9.6 inches. Only two of the stands have an average dbh greater than 12 inches.

**Basal Area** – Stand basal area ranges from 60 to 105 and averages 85 square feet per acre. Two stands, totaling 4.9 acres, have a basal area greater than 100 square feet per acre while three stands, totaling 44.8 acres, have a basal area less than 70 square feet per acre.

**Number of Trees per Acre** – The number of trees per acre in the stands ranges from 364 to 1,401 and averages 595. The number of trees per acre exceeds 900 in only one stand. Most of the stands have 300-750 trees per acre.

**EAB Hazard Rating** – Six stands totaling 25.3 acres have a "low" EAB hazard rating, three stands covering 51.4 acres have a "moderate" EAB hazard rating, one stand covering 4.5 acres has a "high" EAB hazard rating and two stands totaling 4.1 acres have a "very high" EAB hazard rating. The EAB hazard rating map is presented in Figure 4.

**Gypsy Moth Hazard Rating** – Three stands totaling 43.0 acres have a "low" gypsy moth hazard rating, eight stands totaling 36.2 acres have a "moderate" hazard rating and one stand covering 6.1 acres has a "high" hazard rating. None of the stands have a "very high" hazard rating. The gypsy moth hazard map is presented in Figure 5.

**Cover Type** – Six stands, totaling 31.9 acres were classified as "oak-hickory" cover type while six stands totaling 53.4 acres, were classified as "elm-ash-cottonwood" forest type. A forest cover type map is presented in Figure 6.

**Species Composition** – There were 31 tree species observed in the 10 BAF prism plots (Table 1). Some tree species like American elm were found in most stands while other species like American beech were in very limited numbers in only a stand or two. Tree species like hawthorn

usually had a smaller basal area while species like northern red oak had a much larger basal area component.

Species composition data from individual stands was combined to obtain site-wide information. The ten most abundant trees in descending order are American elm, sugar maple, shagbark hickory, hawthorn, white ash, black walnut, bitternut hickory, green ash, northern red oak and northern hackberry. The ten tree species with the most basal area in descending order are American elm, white ash, shagbark hickory, northern red oak, eastern cottonwood, sugar maple, green ash, pin oak and hawthorn. American elm is both the most abundant tree and has the highest basal area, shagbark hickory is the third most abundant tree and has the third most basal area while hawthorn is the fourth most abundant tree but has only the tenth most basal area. The site-wide basal area number and trees per acre number for each individual tree species were combined in order to determine the most important tree species. The ten most important species in descending order are American elm, shagbark hickory, white ash, sugar maple, hawthorn, northern red oak, black walnut, green ash, bitternut hickory and eastern cottonwood. Four of the ten most important species are from the "elm-ash-cottonwood" cover type and three of ten are from the "oak-hickory" cover type.

**Size Class Distribution** – At least 89 percent of the trees per acre for each stand were in the less than 12" dbh class. Basal area in this class was the highest in every stand except Stand 5 where basal area in the 12-20" dbh class exceeded it by 5 percent. Stands 6, 8, 9, 10, 11 and 12, totaling 54.2 acres, have no trees per acre or basal area in the greater than 20" dbh class. Stands 1-5 and 7 have both trees per acre and basal area in all three size classes. The largest size class in these six stands accounts for approximately 1 percent of the trees and 12 percent or less of the basal area in each stand.

**Regeneration** – Regeneration was composed of twelve commercial tree species, 7 non-commercial tree or shrub species, two species of woody stems (multi-flora rose and rubus species), 3 species of vines and miscellaneous herbaceous material (Table 2). Commercial stems average 3,385 per acre while non-commercial stems average 3,524 per acre. Vines and miscellaneous herbaceous material, on average, cover approximately 36 percent of the ground in the stands. White ash and green ash were the most common commercial seedling in nine out of twelve stands. Even though American elm was the most common tree in the prism plots, it wasn't found in any of the regeneration plots. However, there were an abundance of 2"- 4" dbh American elms in the prism plots.

**Field Notes** – Some of the stands showed a great deal of diversity, both in species composition and size class distribution. Several stands have at least 14 tree species (not including regeneration) and have trees in all three size classes. Most of the harvesting operation of 1985 was conducted in Stands 3 and 4. Mortality is fairly minimal with a site-wide average of 33 trees per acre and 6 square feet of basal area per acre. Although Stand 8 had the largest amount of mortality (147 trees per acre/25 square feet of basal area per acre), it was one of the densest stands as it had the highest basal area and the second highest number of trees per acre. Approximately half of the site-wide mortality occurred on either intermediate or suppressed trees.

Figure 3. Forest stand map of JSMC-LIMA

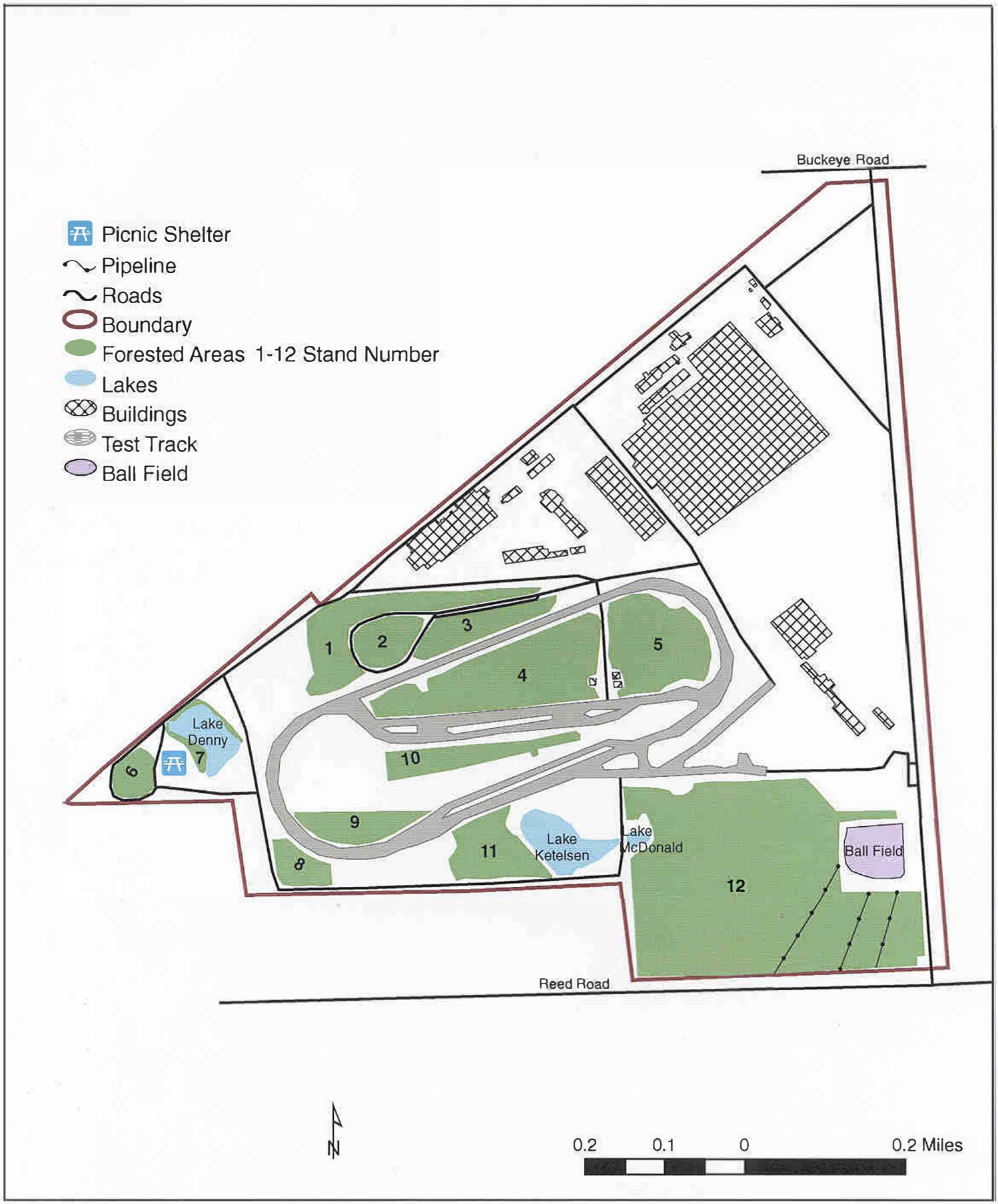


Figure 4. EAB hazard map of JSMC-LIMA

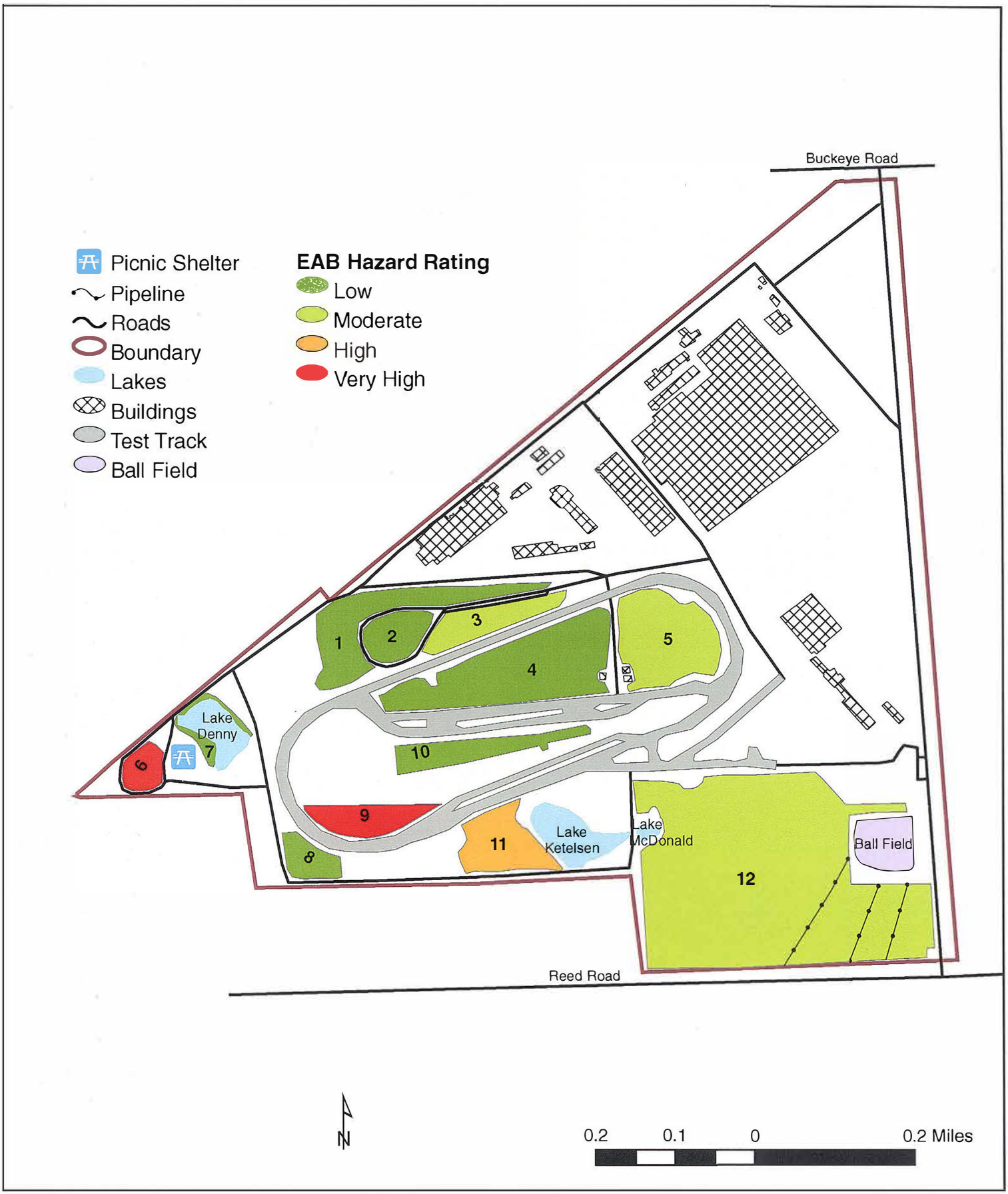


Figure 5. Gypsy moth hazard map of JSMC-LIMA

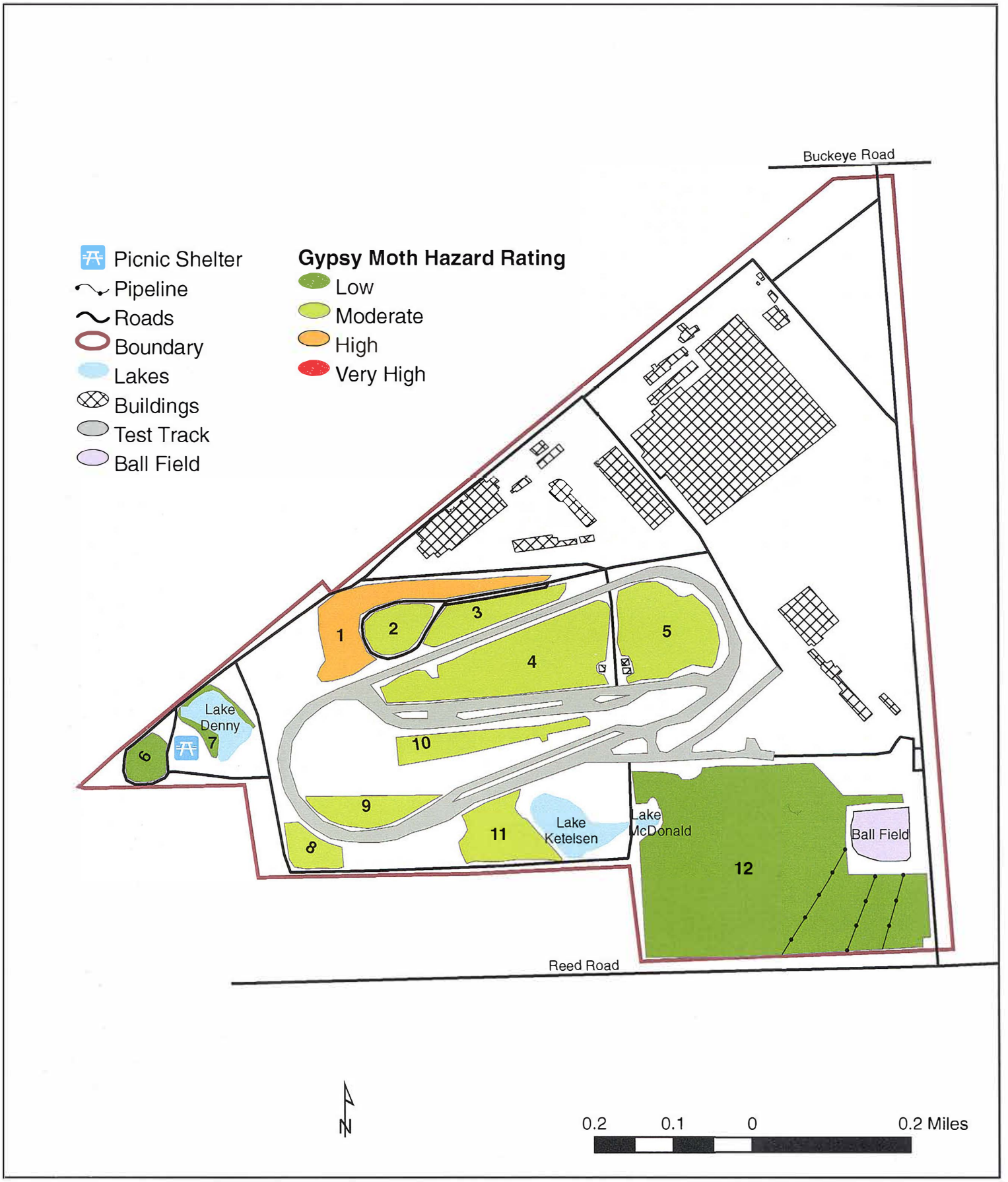


Figure 6. Forest cover type map of JSMC-LIMA

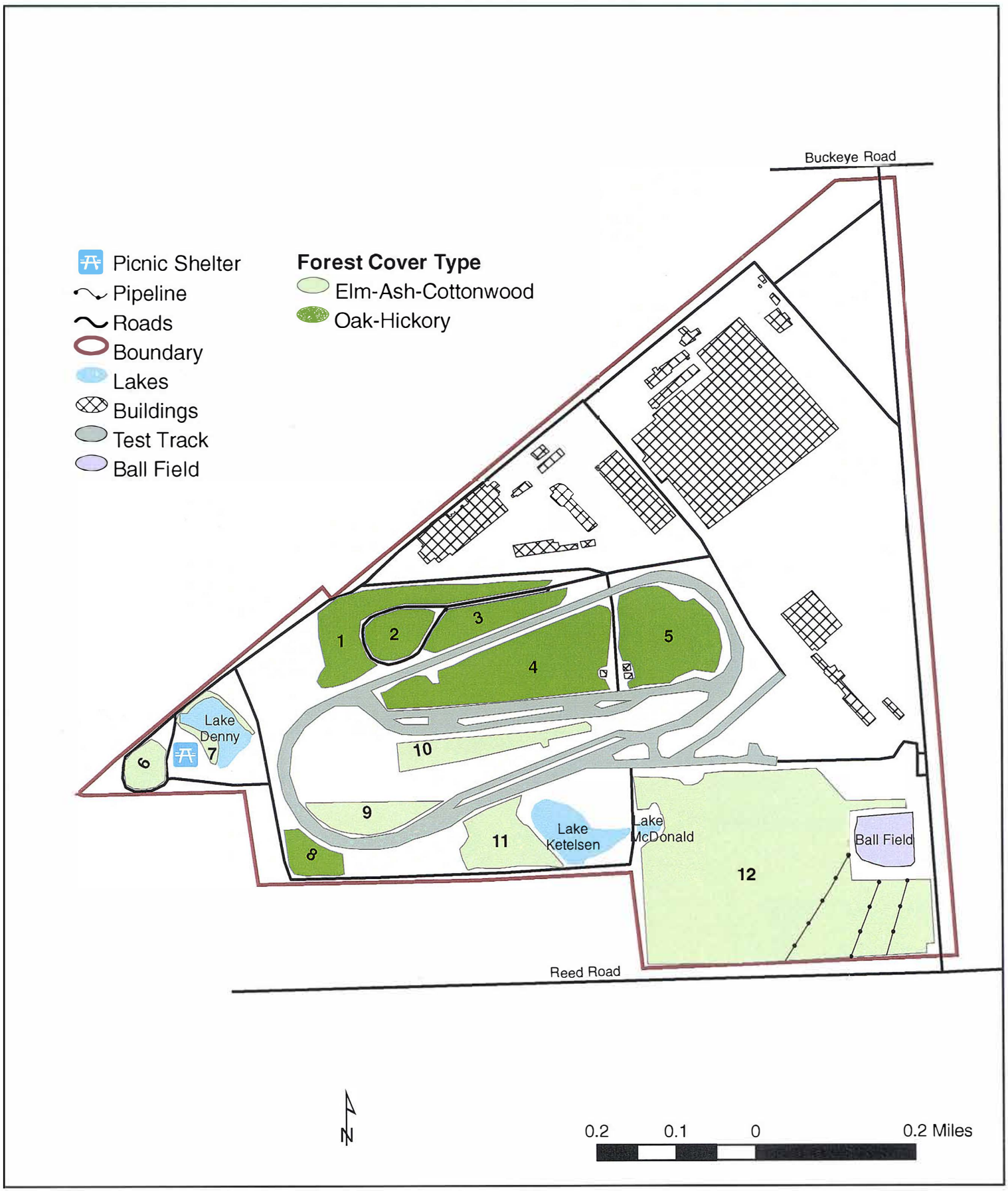


Table 1 – Tree species located in the 10 BAF prism plots

| Common Name | Scientific Name | Acronym |
|---|---|---|
| northern red oak | Quercus rubra | NRO |
| white oak | Quercus alba | WO |
| bur oak | Quercus macrocarpa | BO |
| swamp white oak | Quercus bicolor | SWO |
| pin oak | Quercus palustris | PO |
| white ash | Fraxinus Americana | WA |
| green ash | Fraxinus pennslyvanica | GA |
| American elm | Ulmus Americana | AE |
| slippery elm | Ulmus rubra | SE |
| sugar maple | Acer saccharum | SM |
| silver maple | Acer saccharinum | SIM |
| red maple | Acer rubrum | RM |
| box elder | Acer negundo | BE |
| shagbark hickory | Carya ovata | SH |
| bitternut hickory | Carya cordiformis | BH |
| pignut hickory | Carya glabra | PH |
| shellbark hickory | Carya laciniosa | SHL |
| black cherry | Prunus serotina | BC |
| black walnut | Juglans nigra | BW |
| eastern cottonwood | Populus deltoids | EC |
| bigtooth aspen | Populus grandidentata | BTA |
| American basswood | Tilia Americana | ABA |
| American beech | Fagus grandifolia | ABE |
| hawthorn | Crataegus sp. | HAW |
| honey locust | Gleditsia triacanthos | HL |
| northern hackberry | Celtis occidentalis | NHB |
| common apple | Malus pumila | CAP |
| black willow | Salix nigra | BWI |
| Ohio buckeye | Aesculus glabra | OB |
| hop-hornbeam | Ostrya virginiana | HHB |
| ironwood | Carpinus Carolina | IR |

Table 2 – Tree, shrub, woody stem and vine species located in the regeneration plots.

| Common Name | Scientific Name |
|---|---|
| northern red oak | Quercus rubra |
| white ash | Fraxinus americana |
| green ash | Fraxinus pennsylvanica |
| Ohio buckeye | Aesculus glabra |
| sugar maple | Acer saccharum |
| shagbark hickory | Carya ovata |
| bur oak | Quercus macrocarpa |
| slippery elm | Ulmus rubra |
| American basswood | Tilia americania |
| silver maple | Acer saccharinum |
| black cherry | Prunus serotina |
| northern hackberry | Celtis occidentalis |
| grape vine | Vitis spp. |
| common buckthorn | Rhamnus cathartia |
| Virginia creeper | Parthenocissus guinquefolia |
| poison ivy | Toxicodendron radicans |
| common privet | Ligustrum vulgare |
| spice bush | Lindera benzoin |
| multi-flora rose | Rosa multiflora |
| autumn olive | Elaegnus umbellata |
| blackberry | Rubus spp. |
| red osier dogwood | Cornus sericea |
| hop-hornbean | Ostrya virginiana |
| amur honeysuckle | Lonicera maackii |
| misc. herbaceous material | N/A |

## DISCUSSION AND RECOMMENDATIONS

Although the primary function of JSMC-LIMA is the production and testing of tanks, assault vehicles and various prototypes, the facility has the responsibility as a steward of public land to manage their forest resources by implementing ecologically sound practices. Properly planned and implemented silvicultural treatments can improve the overall "health" of the forested areas while still providing a visual buffer, a noise barrier, wind breaks and wildlife habitat. An integrated pest management strategy should be implemented to reduce the impacts of insects and diseases. Biological, chemical and silvicultural options should be examined for their control.

Stand 10, the 3.2 acre stand located adjacent to the diagonal test track, was harvested in February of 2006. The stand was encroaching on the tank bore site area which bordered the southern edge of the stand and conflicted with a primary function of the facility. After all the woody debris is removed from this stand, it will be planted in grass and converted to a field. Further discussion will not include this area.

The overall health of the forested areas appear to be good. Very little insect and or disease damage was detected. Mortality for the most part was minimal, widely scattered and was probably caused by competition with other trees for growing space, sun light, water and nutrients. Some damage to trees occurred during a winter storm in 2004. Outside of some minor branch breakage, most of the damage was isolated to "edge" trees in Stands 1 and 2. In these tree stands, only 10-20 trees were uprooted and killed.

Most of the stands are fairly immature even though at least half the stands have some mature trees (dbh>20"). Generally, the "oak-hickory" classified stands are more mature and have more size class diversity than the "elm-ash-cottonwood" classified stands.

There was a great deal of species diversity at JSMC-LIMA. There were 31 tree species, 6 shrub species, 3 vine species, 2 woody stem species and several species of herbaceous material observed. This diversity can help reduce the potential impact of any impact or disease outbreak. As a whole, the "oak-hickory" classified stands had more diversity than the "elm-ash-cottonwood" classified stands.

The biggest threat to the forest resources at JSMC-LIMA is probably the EAB. As of April 2006, the closest EAB infestation is located only 7 miles away near the town of Wapakoneta (Figure 7). The EAB was first detected in Ohio in 2003 and has now been detected in 13 counties (Figure 8). Over half the forested acres at the site have at least a moderate EAB hazard rating. Currently in the state of Ohio, a quarantine area is set up around known EAB infested trees and all ash are cut and removed within a ½ mile radius. It is likely that JSMC-LIMA will be infested with EAB, within the next ten years.

To prevent economic loss and potential negative impacts such as a reduction in the visual and noise buffering capacity, an increase in the number of hazard trees and an increase in exotic invasive plants, silvicultural treatments should be implemented to reduce the amount of ash. If no silvicultural treatments are implemented and EAB infests the site, it is likely that most of the ash will die within 5 years. This would eliminate 2 out of the 10 most important tree species at JSMC-LIMA and significantly reduce the basal area and number of trees in some of the stands.

In order to reduce the negative impacts EAB will have at JCMC-LIMA, both white and green ash should be harvested in the stands that have a "moderate" or higher EAB hazard rating. Silvicultural reduction of ash should be concentrated on trees 10" and larger and should not remove more than 20 percent of the total basal area in a stand at any time. It is likely that this can be done through a commercial harvesting operation. Also during this operation, any commercially valuable tree that has more than 50 percent crown dieback should be harvested.

Another large threat to the forest resources at JSMC-LIMA is the gypsy moth. Although no gypsy moth caused defoliation has been detected at, or in the vicinity of the site, gypsy moth will eventually arrive. Mortality after a single defoliation can be significant during droughty conditions and likely to be concentrated on oak species, which are valuable for both timber production and production of hard mast. Gypsy moth population should be monitored on an annual basis in eight stands that have either a moderate or high gypsy moth hazard rating. Intervention tactics such as aerial suppression projects should be conducted when the population densities are sufficient to cause noticeable defoliation.

Two other potential threats to the forest resources at JSMC-LIMA are the Asian longhorned beetle and the white-tailed deer. The Asian longhorned beetle (ALB), *Anoplophora glabripennis*, is an exotic species from China that feeds on various species of maples, box elder, birches, alder, elms, horse chestnut, poplars and willows. The larvae of this beetle tunnel through the tree's bark to feed in the wood. This tunneling can girdle the stem and branches of the tree. Repeated attacks lead to crown dieback and eventually, death of the tree. During this decade, ALB infestation have been detected in Chicago, New York City and Carteret, New Jersey. The only effective way to eliminate ALB is to remove infested trees and destroy them by chipping and burning. The most common method of introduction into the U.S. is in untreated wood packing materials such as pallets and crates. Fortunately, all the wood packaging material utilized at this site is heat treated. Chemical or heat treatment of all wood packaging material from China is recommended to prevent ALB infestations.

Although a few deer were sighted during the cruise and numerous trails were detected, white-tailed deer are currently not having a significant impact at JSMC-LIMA. No deer damaged seedlings were detected and some stands even had a significant amount of oak regeneration. Oaks are one of the preferred seedlings for deer to browse. An expanding deer population will have adverse impacts on seedling regeneration. A single deer can consume 2-3.3 pounds of vegetation daily, consisting of woody browse, acorns, grass and herbaceous material (Smith 1993). The long term effects of a high deer population on forest resources is to retard the process of regeneration, selectively change species composition, and reduce the overall diversity of tree and plant species. The best way to control a deer herd and prevent these unwanted deer caused impacts on forest resources is through regulated hunting.

To improve individual tree vigor, stimulate dbh and crown growth, increase tree value and increase mast production, a silvicultural option known as crop tree management should be implemented. Four to six crop trees per acre should be identified, marked and then receive a 3-4 sided crown release from competing trees. The crop trees selected should be 10-18" dbh, healthy, show no signs of insects or disease, have well formed crowns and should include various species oaks, hickories, American elm, sugar maple and black walnut. The dbh growth rate can be accelerated by 50 to 100 percent on in the selected crop trees (Perkey 2000). Mast production from mast producing crop trees is likely to exceed mast production of similar size non-crop tree mast producers (Whiteman 2005). This increased mast production will benefit many species of wildlife. Once the canopy has closed from this silviculture treatment, additional

crop trees can be selected and released. Care should be given to avoid opening up a stand too much which could stimulate the growth of unwanted invasive species.

Unfortunately, some of the stands already contain a large number of exotic invasive species. The exotic invasive species encountered at JSMC-LIMA include autumn olive, amur honeysuckle, common buckthorn and multi-flora rose. For the most part these invasive species are found in openings, open forests, forest edges, along roadsides and in abandoned fields. These species often out-compete native vegetation, thus retarding tree regeneration and diversity. Due to the small size of the forested areas at JSMC-LIMA, a large portion of most stands are located fairly close to the forest edge. Invasive species dominate the understory in Stands 8, 9, 11 and 12. Chemical and mechanical treatments should be implemented in all stands to reduce these unwanted plants. Reduction of these exotic invasive species will provide more growing space for desirable regeneration.

Another location at JSMC-LIMA that contains trees is the area around the picnic shelter which is located west of Lake Denney. This area is comprised by species such as shagbark hickory, white oak, white ash, sugar maple, northern red oak and black walnut that range from 12-26" dbh. This high-use recreational area is 2-3 acres in size, has trees spaced between 30-75 feet apart and has a mowed grass understory. To prevent injury or death from getting hit by a falling tree, hazardous trees (dead and or unsound) should be removed on a regular basis. Dead branches should also be removed from living trees.

Two abandoned fields, one located between Stands 1 and 7 and the other one located between Stands 8 and 11, are slowly reverting back to forest land. If this is desirable, a mixture of seedlings should be planted in both these areas to accelerate establishment of a more commercially valuable forest. Both hardwoods and conifers should be planted. The conifers will provide good habitat for wildlife, especially in the winter months and are much better wind breaks. If fields are desired for these areas, they should be mowed (brush-hogged) on an annual basis.

Figure 7. Location map of JSMC-LIMA and EAB infestation in Auglaize County.

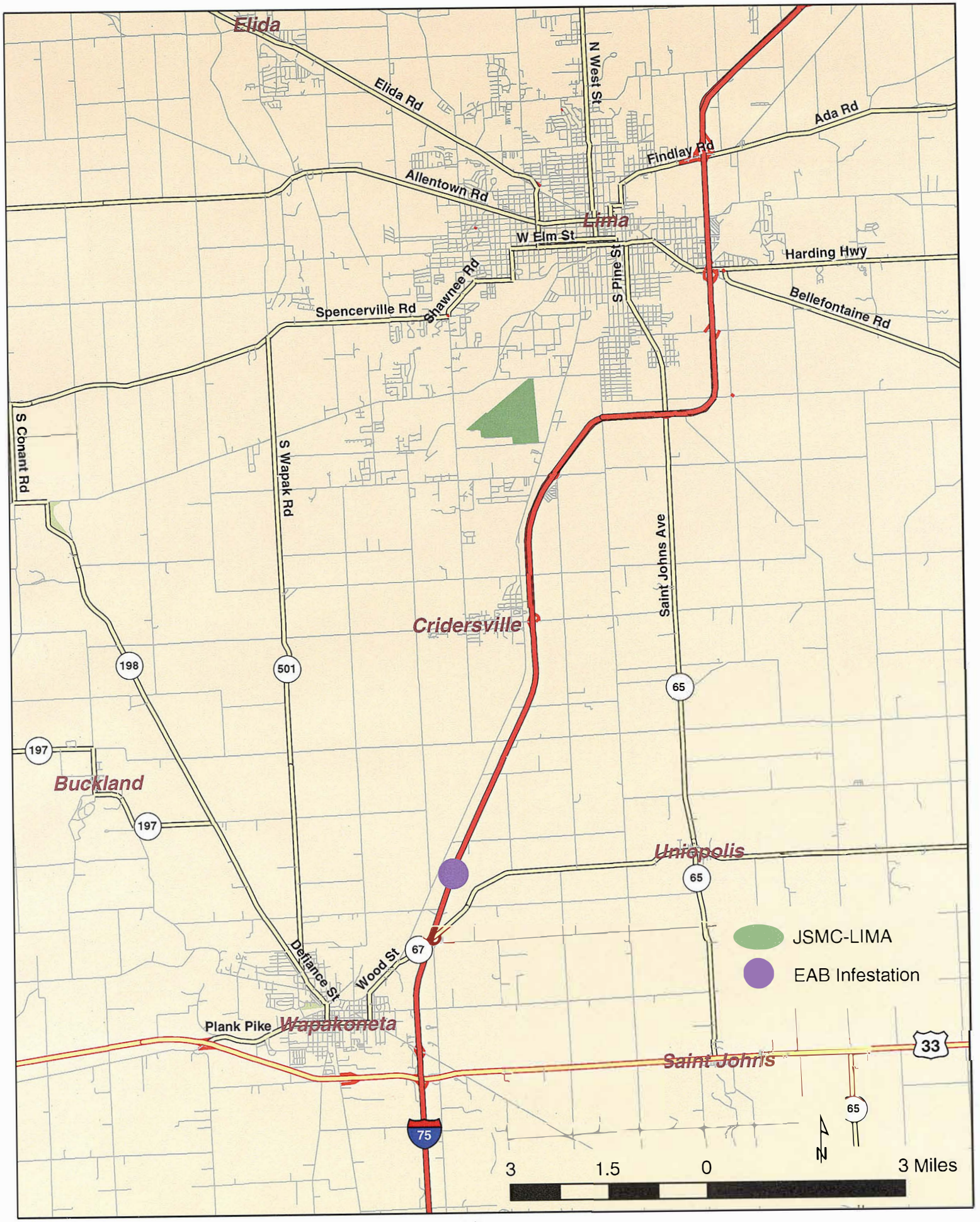


Figure 8. Counties in Ohio where EAB infestations have been found as of December 2006

## WORK SCHEDULE

| When | What | Where |
|---|---|---|
| Annual | Gypsy moth egg mass survey | Stands 1, 2, 3, 4, 5, 8, 9, and 11 |
| 2007 or 2008 | Crop tree management | Stands 1, 2, 3, 4, 5, 8, 9, 11 and 12 |
| 2007 or 2008 | Ash reduction and removal of declining trees | Stands 3, 5, 6, 9, 11 and 12 |
| Annual | Deer hunting | Stands 1, 2, 3, 4, 5, 8, 9, 11 and 12 |
| 2007 or 2008 | Invasive species reduction | Stands 1, 2, 3, 4, 5, 6, 7, 8, 9, 11 and 12 |
| Annual | Hazard tree reduction | Picnic shelter area |
| Annual | Brush hogging | Fields between Stands 1 and 7 and Stands 8 and 11 |
| or | or | |
| 2007 or 2008 | Seedling planting | Fields between stands 1 and 7 and Stands 8 and 11 |

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# APPENDIX A

## Individual Stand Data

Stand Number: 1
Average DBH: 10.4"
Number of trees per acre: 525
EAB Hazard Rating: Low

Acres: 6.1
Basal Area: 85 square feet/acre
Cover Type: Oak-Hickory
Gypsy Moth Hazard Rating: High

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | NRO | 32% | (34%), | BH | 16% | (10%), | SH | 10% | (12%), |
| | HAW | 8% | (3%), | BO | 7% | (15%), | BC | 7% | (2%), |
| | GA | 4% | (7%), | AE | 3% | (2%), | HL | 3% | (3%), |
| | WA | 2% | (3%), | SM | 2% | (1%), | SWO | 1% | (2%), |
| | PO | 1% | (1%), | HHB | 1% | (1%), | PH | 1% | (1%), |
| | BW | 1% | (1%) | | | | | | |

| Size Class Distribution: | | | |
|---|---|---|---|
| | <12" dbh | 96% | (75%) |
| | 12-20" dbh | 3% | (15%) |
| | > 20" dbh | 1% | (10%) |

Regeneration: White ash, green ash, Ohio buckeye, northern red oak, sugar maple, shagbark hickory, bur oak and bitternut hickory account for 3,949 stems per acre. White ash and green ash account for 79 percent of these stems. Non-commercial species such as blackberry, ironwood, hop-hornbeam, multiflora rose, spice bush, common buckthorn, amur honeysuckle and red osier dogwood account for an additional 3,631 stems per acre. Herbaceous material, poison ivy, grape vine and Virginia creeper combined average approximately 30% ground cover. Grape vines are very numerous in one area of the stand.

Field Notes: Mortality accounts for an additional 50 trees per acre and 8 square feet of basal area per acre. There were a few trees located against the road that borders this stand that were uprooted during a storm during the winter of 2004. There is a great deal of variation in this stand with respect to species composition and tree size.

Stand Number: 2
Average DBH: 11.1"
Number of trees per acre: 612
EAB Hazard Rating: Low

Acres: 2.3
Basal Area: 85 square feet/acre
Cover Type: Oak-Hickory
Gypsy Moth Hazard Rating: Moderate

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | AE | 31% | (10%), | BH | 25% | (10%), | SM | 13% | (12%), |
| | EC | 4% | (3%), | PH | 3% | (6%), | SH | 3% | (14%), |
| | NRO | 2% | (18%), | HL | 2% | (3%), | BC | 2% | (3%), |
| | BO | 2% | (9%), | PO | 1% | (3%), | SWO | 1% | (2%), |
| | WO | 1% | (3%) | | | | | | |

| Size Class Distribution: | | | |
|---|---|---|---|
| | <12" dbh | 96% | (65%) |

| | | |
|---|---|---|
| 12-20" dbh | 3% | (26%) |
| > 20" dbh | 1% | (9%) |

Regeneration: White ash and green ash account for 5,500 stems per acre while black cherry, Ohio buckeye, shagbark hickory and slippery elm total 2,000 stems per acre. Non-commercial species such as hawthorn, hop-hornbean and common privet account for another 1,000 stems per acre. Herbaceous material averages approximately 25 percent ground cover.

Field Notes: Mortality accounts for an additional 2 square feet of basal and 2 trees per acre. There was also a few more trees located against the road that completely borders this stand that was uprooted during a storm during the winter of 2004. There is a great deal of variation in this stand with respect to species composition and tree size.

Stand Number: 3
Average DBH: 9.8"
Number of trees per acre: 586
EAB Hazard Rating: Moderate

Acres: 3.4
Basal Area: 97 square feet/acre
Cover Type: Oak-Hickory
Gypsy Moth Hazard Rating: Moderate

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | SH | 29% | (20%), | BH | 22% | (10%), | AE | 10% | (2%), |
| | NRO | 7% | (21%), | GA | 7% | (9%), | BO | 6% | (10%), |
| | PH | 5% | (5%), | SE | 4% | (4%), | RM | 3% | (2%), |
| | WA | 2% | (3%), | PO | 2% | (3%), | EC | 1% | (9%), |
| | ABA | 1% | (3%), | SWO | 1% | (2%) | | | |

| Size Class Distribution: | | | |
|---|---|---|---|
| | <12" dbh | 94% | (77%) |
| | 12-20" dbh | 5% | (19%) |
| | >20" dbh | 1% | (4%) |

Regeneration: White ash, green ash, northern red oak, black cherry, shagbark hickory, bur oak, Ohio buckeye and American basswood total 5,000 stems per acre, half of which are ash. Non-commercial species such as amur honeysuckle, multiflora rose, common buckthorn and hop-hornbean account for an additional 2,266 stems per acre. Poison ivy, Virginia creeper, grape vine and herbaceous material combined average approximately 75 percent ground cover.

Field Notes: Mortality accounts for an additional 8 square feet of basal acre per acre and 16 trees per acre. Some trees were harvested from this stand in 1985. There is a great deal of variation in this stand with respect to species composition and tree size.

Stand Number: 4
Average DBH: 12.6"
Number of trees per acre: 632
EAB Hazard Rating: Low

Acres: 11.1
Basal Area: 97 square feet/acre
Cover Type: Oak-Hickory
Gypsy Moth Hazard Rating: Moderate

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | SM | 43% | (24%), | BH | 14% | (7%), | HAW | 7% | (1%), |
| | SIM | 6% | (6%), | NRO | 5% | (19%), | ABA | 2% | (1%), |
| | BC | 2% | (1%), | EC | 2% | (3%), | WO | 1% | (2%), |
| | SWO | 1% | (4%), | PH | 1% | (3%), | GA | 1% | (2%), |
| | WA | 1% | (1%), | ABE | 1% | (1%), | BO | 1% | (6%), |
| | PO | 1% | (3%), | SE | 1% | (1%), | SLH | 1% | (1%) |

| Size Class Distribution: | | | |
|---|---|---|---|
| | <12" dbh | 95% | (60%) |
| | 12-20" dbh | 4% | (31%) |
| | >20" dbh | 1% | (9%) |

Regeneration: White ash, green ash, silver maple, black cherry, northern hackberry, shagbark hickory and red oak total 6,337 stems per acre. Ash accounts for 48 percent of the stems. Non-commercial species such as hop-hornbean, blackberry, amur honeysuckle and multiflora rose total 1, 777 stems per acre. Poison ivy, grape vine and Virginia creeper and herbaceous material average approximately 25 % ground cover.

Field Notes: Mortality accounts for an additional 5 square feet of basal area per acre and 45 trees per acre. Some trees in this stand were harvested in 1985. Very diverse stand in terms of species composition and tree size. Sugar maple comprises a significant portion of the stand.

Stand Number: 5
Average DBH: 13.2"
Number of trees per acre: 397
EAB Hazard Rating: Moderate

Acres: 7.3
Basal Area: 93 square feet/acre
Cover Type: Oak-Hickory
Gypsy Moth Hazard Rating: Moderate

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | SM | 37% | (11%), | RM | 22% | (2%), | AE | 14% | (9%), |
| | SH | 7% | (27%), | GA | 4% | (6%), | WA | 4% | (5%), |
| | ABA | 3% | (6%), | SE | 3% | (2%), | BO | 1% | (11%), |
| | NRO | 1% | (11%), | BC | 1% | (2%), | ABE | 1% | (3%), |
| | SWO | 1% | (2%), | SHL | 1% | (3%) | | | |

| Size Class Distribution: | | | |
|---|---|---|---|
| | < 12" dbh | 89% | (42%) |
| | 12-20" dbh | 10% | (47%) |
| | >20" dbh | 1% | (11%) |

Regeneration: Green ash, white ash, American basswood, black cherry, Ohio buckeye, shagbark hickory and bur oak total 4,125 stems per acre with ash accounting for 45 percent of the stems. Non-commercial species such as hop-hornbean, multiflora rose, black cherry, and amur honeysuckle account for an additional 1,875 stems per acre. Virginia creeper, poison ivy, grape vine and herbaceous material combined average approximately 40% ground cover.

Field Notes: Mortality accounts for an additional 8 square feet of basal area per acre and 16 trees per acre. Some trees in this stand were harvested in 1985. This stand is the most mature of any of the stands. Very diverse stand in terms of both tree size and species composition.

Stand Number: 6
Average DBH: 8.6"
Number of trees per acre: 383
EAB Hazard Rating: Very High

Acres: 1.4
Basal Area: 65 square feet/acre
Cover Type: Elm-Ash-Cottonwood
Gypsy Moth Hazard Rating: Low

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BW | 32% | (15%), | WA | 24% | (30%), | GA | 20% | (24%), |
| | BC | 13% | (15%), | AE | 6% | (7%), | SM | 4% | (8%), |
| | SE | 1% | (1%) | | | | | | |

| Size Class Distribution: | | |
|---|---|---|
| <12" dbh | 95% | (77%) |
| 12-20" dbh | 5% | (23%) |
| >20" dbh | 0% | (0%) |

Regeneration: Sugar maple accounts for 3,500 stems per acre. Non-commercial species such as common buckthorn and amur honeysuckle account for an additional 7,500 stems per acre. Herbaceous material covers approximately 10 percent of the ground in the stand.

Field Notes: Mortality accounts for an additional 1 square foot of basal area per acre and 3 trees per acre. This small stand is very immature with the bulk of the trees having a dbh ranging from 6-12 inches. The regeneration is dominated by non-commercial species.

Stand Number: 7
Average DBH: 8.6"
Number of trees per acre: 500
EAB Hazard Rating: Low

Acres: .9
Basal Area: 79 square feet/acre
Cover Type: Elm-Ash-Cottonwood
Gypsy Moth Hazard Rating: Low

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | NHB | 39% | (9%), | SM | 21% | (22%), | AE | 18% | (27%), |
| | BWI | 6% | (3%), | BC | 6% | (13%), | WA | 4% | (5%), |
| | EC | 2% | (13%), | SE | 2% | (3%), | SH | 1% | (3%), |
| | WO | 1% | (2%) | | | | | | |

| Size Class Distribution: | | |
|---|---|---|
| < 12" dbh | 95% | (76%) |

| | | |
|---|---|---|
| 12-20" dbh | 4% | (21%) |
| >20" dbh | 1% | (3%) |

Regeneration: Sugar maple, northern hackberry and white ash account for 2,667 stems per acre. Understory and mid-story species such as amur honeysuckle and common buckthorn account for an additional 1,834 stems per acre. Herbaceous material, grape vine and poison ivy combined average approximately 10 percent ground coverage.

Field Notes: This very small stand is a thin strip of trees that border Lake Denny on three sides. Mortality accounts for an additional 6 square feet of basal area per acre and 38 trees per acre.

Stand Number: 8
Average DBH: 8.4"
Number of trees per acre: 890
EAB Hazard Rating: Low

Acres: 1.7
Basal Area: 105 square feet/acre
Cover Type: Oak-Hickory
Gypsy Moth Hazard Rating: Moderate

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | SH | 65% | (27%), | AE | 13% | (10%), | HL | 7% | (10%), |
| | PO | 5% | (28%), | WA | 4% | (10%), | SM | 3% | (5%), |
| | BE | 2% | (5%) | EC | 1% | (5%) | | | |

| Size Class Distribution: | | |
|---|---|---|
| < 12" dbh | 95% | (68%) |
| 12-20" dbh | 5% | (32%) |
| >20" dbh | 0% | (0%) |

Regeneration: White ash account for 1,500 stems per acre. Non-commercial species such as common buckthorn, amur honeysuckle and multiflora rose account for an additional 10,500 stems per acre.

Field Notes: Mortality accounts for an additional 25 square feet of basal area per acre and 147 trees per acre. This is a very dense young stand that is dominated by non-commercial regeneration.

Stand Number: 9
Average DBH: 8.6"
Number of trees per acre: 417
EAB Hazard Rating: Very High

Acres: 2.7
Basal Area: 60 square feet/acre
Cover Type: Elm-Ash-Cottonwood
Gypsy Moth Hazard Rating: Moderate

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | HAW | 50% | (29%), | WA | 41% | (46%), | RM | 5% | (13%), |
| | PO | 2% | (8%), | AE | 2% | (4%) | | | |

| Size Class Distribution: | | |
|---|---|---|
| <12" dbh | 96% | (71%) |
| 12-20" dbh | 4% | (29%) |
| >20" dbh | 0% | (0%) |

Regeneration: White ash accounts for 2,000 stems per acre. Non commercial species such as amur honeysuckle, common buckthorn and blackberry account for 3,500 stems per acre. Herbaceous material and poison ivy combined average approximately 40 percent ground cover.

Field Notes: Although classifieds as "Elm-Ash-Cottonwood" forest type, the most common tree is hawthorn. Most of these are approximately 2"- 4" dbh. Mortality accounts for an additional two square feet of basal area per acre and 13 trees per acre.

Stand Number: 10
Average DBH: 6.4"
Number of trees per acre: 1401
EAB Hazard Rating: Low

Acres: 3.2
Basal Area: 103 square feet/acre
Cover Type: Elm-Ash-Cottonwood
Gypsy Moth Hazard Rating: Moderate

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HAW | 56% | (23%), | AE | 17% | (23%), | WA | 9% | (10%), |
| RM | 9% | (10%), | BC | 3% | (9%), | EC | 2% | (15%), |
| PO | 2% | (6%) | BO | 1% | (3%), | BW | 1% | (1%) |

| Size Class Distribution: | | |
|---|---|---|
| < 12" dbh | 99% | (87%) |
| 12-20" dbh | 1% | (13%) |
| >20" dbh | 0% | (0%) |

Regeneration: Green ash and white ash account for 3,286 stems per acre. Non-commercial species such as multiflora rose, amur honeysuckle, blackberry, hop-hornbean and common buckthorn account for an additional 3,814 stems per acre. Herbaceous material, grape vine and poison ivy combined average approximately 45 percent ground cover.

Field Notes: Mortality accounts for an additional 3 square feet of basal area per acre and 31 trees per acre. Although this stand is classified as Elm-Ash-Cottonwood forest type, hawthorn is the most common tree. The understory in this stand is fairly thick. This stand was encroaching on the tank bore site area and was harvested in February of 2006.

Stand Number: 11
Average DBH: 9.4"
Number of trees per acre: 438
EAB Hazard Rating: High

Acres:4.5
Basal Area: 85 square feet/acre
Cover Type: Elm-Ash-Cottonwood
Gypsy Moth Hazard Rating: Moderate

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| AE | 60% | (26%), | BE | 10% | (21%), | WA | 9% | (15%), |
| GA | 6% | (11%), | CAP | 6% | (3%), | PO | 4% | (15%), |
| EC | 3% | (3%), | NRO | 2% | (6%) | | | |

| Size Class Distribution: | | |
|---|---|---|
| <12" dbh | 95% | (77%) |
| 12-20" dbh | 5% | (23%) |
| >20" dbh | 0% | (0%) |

Regeneration: Green and white ash account for 750 stems per acre. Non-commercial species such as multiflora rose, amur honeysuckle and common buckthorn account for an additional 2,750 stems per acre. Herbaceous material averages approximately 20 percent ground cover.

Field Notes: Mortality accounts for an additional 3 square feet of basal area per acre and 28 trees per acre. Non-commercial species comprise the bulk of the regeneration in the stand. American elm, white ash and green ash account for the majority of the trees in this stand.

Stand Number: 12
Average DBH: 8.3"
Number of trees per acre: 364
EAB Hazard Rating: Moderate

Acres: 40.7
Basal Area: 68 square feet/acre
Cover Type: Elm-Ash-Cottonwood
Gypsy Moth Hazard Rating: Low

| Species Composition: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BW | 49% | (35%), | AE | 17% | (6%), | EC | 15% | (38%), |
| | GA | 12% | (12%), | PO | 3% | (3%), | SH | 1% | (3%), |
| | BC | 1% | (1%), | NHB | 1% | (1%), | BTA | 1% | (1%) |

| Size Class Distribution: | | | |
|---|---|---|---|
| | <12" dbh | 96% | (79%) |
| | 12-20" dbh | 4% | (21%) |
| | > 20" dbh | 0% | (0%) |

Regeneration: Non commercial species such as blackberry, amur honeysuckle, red osier dogwood, multiflora rose, autumn olive and common buckthorn account for 1,945 stems per acre. Herbaceous ground cover average approximately 80 percent.

Field Notes: This stand originated from an abandoned field. Most, if not all, of the black walnut in this stand were planted. Without the black walnut, "elm-oak-cottonwood" forest type would comprise the vast majority of the stand. There are a lot of small scattered wetlands in the stand. This stand has been designated as a wildlife viewing area and is located outside of the security fence. Mortality accounts for an additional 2 square feet of basal area per acre and 4 trees per acre. The numerous white-tailed deer were observed in this stand during the cruise.